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(54) Title: METHOD AND APPARATUS FOR THE PRODUCTION OF SO CALLED "FRACTIONAL HYDROGEN" AND ASSOCIATED PRODUCTION OF PHOTON ENERGY

(57) Abstract: An enclosed system, which generally may be of tubular shape, in which plasma of hydrogen is induced, or is being created and in which this plasma is being maintained. Said system comprising of an anode at one end of the enclosed system and a cathode at the other end; optionally, means for electromagnetic focusing (e.g. by means of Helmholtz pairs) surrounding said enclosed system; coiling, screen(s) or strips, which may have a variety of shapes, positioned within said enclosed system and being located between said anode and said cathode, but not being connected to either and which may consist of a material (e.g. W), which promotes the conversion of molecular hydrogen into atomic hydrogen and which further facilitates the molecular hydrogen into atomic hydrogen and which further facilitates the ionization of hydrogen; said coiling, screen(s) or strips, which may have a variety of shapes, optionally being hooked up to a minute electric power source, which preferably has a relatively high frequency.

METHOD AND APPARATUS FOR THE PRODUCTION OF SO CALLED ''FRACTIONAL HYDROGEN'' AND ASSOCIATED PRODUCTION OF PHOTON ENERGY

BACKGROUND

The background of this Invention relates mostly to astronomical observations, some of which are of the last few decades.

It has been noted that when looking at the Abundancy Curve of the elements, which are known to exist in our universe, that the elements Li, Be and B are very scarce in relation to their location in the Periodical System. (See Fig. 1; the Abundancy Curve of the elements). There must be reasons for this. The factors: pressure, temperature and other parameters e.g. certain configurations in their respective nuclei, whereby these named elements are being converted, apparently are occurring rather frequently in many locations in the universe, wherefore we can assume that the values of the factors which allow conversions of these elements, either `upwardly' via nucleo-synthesis processes into heavier elements, or `downwardly' by means of fission to hydrogen or helium or isotopes thereof ($He_2^4, He_2^3, H_1^3, H_1^2, H_1^1$) are favorable for such conversions to take place. Also it became clear to Inventor that certain isotopes of Li, Be and B can act as catalysts in certain processes. Whereas these elements carry few electrons, their nuclei are easily approachable by elementary ``particles'', e.g. protons. In this Invention use is made of the properties of certain isotopes of $Li, Be$ and $B$, which carry an extra neutron, in a function as ``nucleonic catalysts''. This is a new concept; so far catalysts always only referred to actions by electrons in the outer shell of atoms.

Furthermore in a different category of astronomical observations in deep space, (in numerous locations by now) but also in solar flares in the corona of the sun, spectral lines were found which can be attributed to hydrogen in the extreme left UV and in the Soft X-ray areas. These lines correspond with photon energies which are greater than those we are familiar with in the Lyman series. We hereby refer to observations which were made by Labov and Bowyer and by Golub and Pasachoff; (See: Labov, S. , Bowyer, S., 1991, ``Spectral Observations in the extreme Ultra-Violet background'', The Astrophysical Journal, 371, pp. 810-819) and also: Golub, L., Pasachoff, J.M., 1997, ``The Solar Corona'', Chapter 9.3 and in particular p. 294 (Table 9.4), The Cambridge University Press, all of which corroborate hydrogen lines in the extreme UV and Soft X-ray areas. Insertion of these newly found energy data into the Rydberg formula, show correspondence with values for ``n'', which are to be fractions instead of whole numbers. (n is the quantum level number). The Rydberg formula is shown herewith:

$$\nu = \frac{E - E_2}{h} = \frac{me^4 Z^2}{8\varepsilon_0^{\,2} h^3}\left(\frac{1}{n_2^{\,2}} - \frac{1}{n_1^{\,2}}\right), \quad (1) \quad \text{or} \quad \bar{\nu} = R\left(\frac{1}{n_f^{\,2}} - \frac{1}{n_g^{\,2}}\right), (2),$$

wherein $R = 109.7 cm^{-1}$ and $n_f > n_g$, whereby $n = \frac{1}{p}$, wherein $p = 1,2,3,.....$ (p is in whole numbers). In this formula $m = 9.1 \times 10^{-31} kg$, $e = 1.6 \times 10^{-19} Coulomb$, $Z =$ atomic nr. (=1for hydrogen) , $\varepsilon_0 = 8.85 \times 10^{-12} Farad/m$ and $h =$ Planck's const. $= 6.62 \times 10^{-34} Joule\,\text{sec}$ The fractions correspond with quantum-levels below the so called ``ground-state'' and for the forms of hydrogen whereby its electron is at quantum-levels below the ``ground-state'' a new name has come into place for the whole group, namely ``fractional hydrogen''. See Inventor's book Fluidum Continuum Universalis, Part I, Chapter 4.

publicized by www.greatunpublished,com # 270. The energies of the electron of hydrogen are given by the Bohr equation:

$E_{electr.} = -\frac{Z^2 e^2}{8\pi\varepsilon_0 a_H n^2}$ (3) , wherein

a_H =Bohr radius. $E_{electr.} = -\frac{Z^2}{n^2} \times 2.18 \times 10^{-18} Joule$, $E_{electr.} = -\frac{13.6}{n^2} eV$ (4) .

For the ``fractional states'', $n = \frac{1}{p}$, whereby $p = 1,2,3,etc.$ (whole numbers). For the electron-proton distance as function of the quantum-level is valid:

$a_H = .053 \times n^2 \times 10^{-9} m$ and for the orbit velocity as function of the quantum-level we have: $v_{(n)} = \frac{e^2}{2h\varepsilon_0}\frac{1}{n} = 2.2 \times 10^6 \times \frac{1}{n} m.\sec^{-1}$. (5)

Laboratory runs with the processes, which are the subject of this Invention indicate that a mixture of various ``fractional states'' is simultaneously being formed and also that those states appear to be very stable. This was proven in many lab experiments during the second half of the year 2000. Therefore we can say that the ``ground-state'' is that stable state with the highest possible energy. (The ``excited states'' have still more energy, but they are not stable). If various ``fractional states'' exist together or are brought together in process, then reactions between those states can occur, which result in further ionization and further lowering of quantum-level, while photons are being produced. The following general formulation for these reactions is:

$H_{(n_i)} + H_{(n_j)} \Rightarrow H_{(n_k)} + H^+ + e^- + photon$ (6)

wherein $n_i \neq n_j$ and $n_k < n_i$ and $n_k < n_j$

The phenominae of these processes as are described above and of the processes under this Invention in general, are novel. Neither fission, nor fusion or chemical reactions take place. This Invention shows the formation of photon energy in a frequency range, which is safe for all biological life forms, including for humans. The processes involve conversions of hydrogen, whereby in ultimo the net produced photon energy comes at the expense of the `constitutional energy' of the electron itself. The `constitutional energy ` of the electron in the ``ground-state'' is about 511,000 $eV$. For the ``fractional states'' this energy becomes less as the state is a lower one. (See book: Fluidum Continuum Unversalis, Part I, Chapter 4). At this time numerous laboratory runs have been made (more than 1,000 hours), during which ``fractional hydrogen'' and photon energy were being produced. To date, neither Gamma rays, nor Beta radiation, nor Alpha particles were ever observed with running these processes. The produced radiation in its totality is from Blue-Violet to Extreme UV-Soft X-ray. This process technology has been certified by the well known national laboratorium: Applied Technical Services Inc., address: 1280 Field Parkway, Marietta, Ga., 30066, USA. The report number is M14343 and is dated March 01, 2001. This report is made part of this patent application as Exhibit A. The composition of the totality of the radiation depends on the various parameters to the process, including materials compositions of certain parts of the apparatus. Inside the enclosed reactor system, which contains hydrogen at pressures generally lower than atmospheric pressure, plasma is being formed, preferably in the presence of Tungsten (W) after the establishment of a certain electro-static and electro-

magnetic field combination between the cathode and the anode. The Tungsten, which is being applied as a catalytic item, can have a variety of shapes: e.g screen, (either length-wise or cylindrically length-wise), or as a plurality of strips, or as in the shape of a coil, which gave the best results. The plasma in the reactor tends to mostly stay within the coil. Better ionization can be obtained by applying a high frequency AC voltage of minute power to the Tungsten coiling. However in the second half of the year 2000 it became clear that by placing the ends of the coiling close to the cathode and anode, there was sufficient induction in the coiling (caused by the electro-magnetic field component), that satisfactory ionization resulted. The application of coiled Tungsten also eliminated the need for electro-magnetic focusing by means of so called Helmholtz pairs. The start-up of the discharge through the reactor requires a voltage which is higher than the voltage which is in existence during normal operation. When more plasma gets formed (this takes only seconds in case of applying *Be* as ``nucleonic catalyst'', but many minutes if *B* is used for the same function in the cathode assembly), then the voltage differential is lowered to a level, which is just sufficient to maintain a continuous discharge, which means continuous operation of the reactor. As temperatures rise in the reactor system and all processes run easier, then a further gradual decline of the voltage differential is possible; this calls for a voltage control, primarily based on temperature.

In common `discharge tubes' the protons travel to the cathode where they pick up free electrons at the cathode surface by which atoms of ``ground-state'' hydrogen are being formed again, or even ``excited-states'' ($n>1$) in case of plentiful available energy;

(high temperatures and or high voltage differentials within such `discharge tubes'). However if: (a) a more or less pulsed DC voltage is being applied, the character time-function of which is important and (b) an additional component is made part of the cathode or is at least present in the surface of the cathode and which component causes so called ``electro-negative'' areas, which attracts protons (provided that they are at close proximity) without the need of an electric field whatsoever, then a totally different course of events takes place. If `bonding' to the ``electro-negative'' areas, which are an inherent part of the additional component in the cathode, takes place by a certain percentage of the protons, which arrived at close proximity of the cathode surface, then after the point in time when the voltage differential is minimal or zero (which is caused by the intermittently existing electro-static/electro-magnetic field) when the field returns in full force, it will take more energy for free electrons to bond with those protons which are held by the ``electro-negative'' areas of the additional component. To `free' these protons more attractive force needs to be exerted by the free electrons, which can only be achieved by moving in closer to those protons (the force increases with the reciprocal of the square of the distance between electron and proton) then the orbit of the ``ground-state''. Therefore the electrons must `fall' through one or more quantum-levels. The energy conversions which take place correspond with the Rydberg formula, whereby then ``fractions'' e.g. $n=\frac{1}{2},\frac{1}{3},$ .etc are to be inserted in this formula in order to find the photon energy levels. This `falling' through quantum-levels produces energy levels of the photons which correspond with the `depth' of the `fall'.

When ``fractional hydrogen'' is being formed then this mostly occurs as a simultaneous formation of various states. A Table, which shows a number of ``fractional states'' together with their energy levels and energy differentials between the states as well as the corresponding wavelengths has been taken up herein and is shown as Fig.2. Reactions between ``fractional states'' also occur simultaneous with first time formation of ``fractional states'' out of protons, whereby further ionization, photon emission and ``lower'' ``fractional states'' result. The related formulation is equation (6). If for instance a reaction between ``fractional states'' takes place, whereby one ``fractional state'' is $H_{\left(n=\frac{1}{2}\right)}$, then

the wavelengths as function of ΔE are: $\lambda_{(Angstrom)} = \frac{1.24 \times 10^{-4}}{\Delta E(eV)}$ (7)

For all practical purposes ``fractional hydrogen'' is inert and cannot react with Oxygen anymore. It has been observed that when an electron `falls' to a lower quantum-level, sometimes a second electron can attach to the same proton, but then at a different quantum-level (to satisfy the ``Pauli exclusion principle''). In this manner ``Bi-electronic hydrogen'' is being formed, the ions of which are negatively charged $H^{-}\left(\frac{1}{p}\right)$ (8)

See: Fluidum Continuum Universalis, Part I, Chapter 4.2. According to the website of Blacklight power Inc. of Cranbury, N.J., this firm is active in the research and development of new materials, which are based on negatively charged hydrogen ions, which this firm obtains via a different process method. The discovery of ``Bi-electronic hydrogen'' might also become a matter of major advance in chemistry.

The negative hydrogen ion is presently subject to research in a number of labs around the world (e.g. reporting about `Vacuum-UV spectroscopy of the negative hydrogen ion' , refs.: P. Balling et al., Phys. Rev. Lett. 77, 2905 (1996); H. H. Andersen et al., Phys. Rev. Lett. 79, 4770 (1997)). Inventor expects that as result of the launching of the FUSE satellite, which occurred on June 24, 1999 (FUSE stands for: Far Ultraviolet Spectroscopic Explorer) much insight will be obtained with regard to the occurrence and frequency levels, which go with these occurrences of the high energy lines in the spectrum of hydrogen, which have been called herein: ``fractional hydrogen'' lines. A report on the mission of the FUSE program and description of the IDS Computer which commands the FUSE instruments, has recently been given by B. K. Heggestad and R. C. Moore of Johns Hopkins University, Applied Physics Lab., Laurel, Maryland, 20723-6099. Other institutes involved in FUSE related research are: Center for Astrophysics and Space Astronomy, University of Colorado, Boulder, Co.,80304 and Space Sciences Lab of University of California, Berkeley, Ca., 94720. Inventor expects that after practical applications of the process(es) as described in this Invention, which center on ``fractional hydrogen'', will be publicly known, there will be frantic research relative to ``fractional hydrogen'' by labs worldwide. Inventor has indicated in FCU, Part I, Chapter 4, that theoretically 83 quantum-levels or states of ``fractional hydrogen'' are Possible. However, the reaching of very low quantum levels with terrestrial experiments is unlikely; very low states are being reached in certain locations in the cosmos.

Protons can be bound to so called ``electro-negative areas'' in or at the outer perimeter of nuclei. Neutrons, being ``cigar-like'' in shape are equally negative at one end as they are positive at the other end. Nearly always the neutrons have their negative end more or less pointed towards the ``geographical center'' of the nucleus, whereby this negative end functions in keeping two protons attracted and located in close proximity of this negative end, which means that two protons can be kept in close proximity of each other in a nucleus. No need for a ``Strong Force''. This is the mechanism by which nuclei exist and whereby many positive charges/protons are kept together in a small location. The so called ``Strong Force'' is non-existing and is a physical artifact from the 1930-ties, which came into being by way of assumption and because of a lack of understanding of nuclear structure.

``Electro-negative areas'' are such areas in or at the perimeter of nuclei, where there is a need for energy inflow; this inflow can be provided by a proton or by the positive end of a neutron and if the scenario of this mechanism is enacted then the proton or the neutron (with its positive end) is more or less strongly bound to this electro-negative area. See FCU, Part II, Chapter 10, `Nucleosynthesis and the Elements'. Part II will be published by www.greatunpublished.com during the winter of 2001-2002. In the event that a neutron is bound to an ``electro-negative area'' (which is with its positive end), then the negative end of said neutron points outwardly and away from the center of the nucleus. This negative end then can easily function as a proton catcher. Use is made of this characteristic for the workings of the process of this Invention.

Furthermore for nuclei to be approached by protons, it is important that the element has as few electrons at its outside/perimeter as is possible. Logically the elements: Li, Be, B fulfill this requirement and these elements also have isotopes which have an extra neutron to their nuclei. These isotopes are resp. Li_3^7, Be_4^9, B_5^{11} and nature apparently agrees with the theory of nuclear structure as mentioned above, because it shows that these isotopes are the prevailing isotopes in the compositions of these elements as they are found in nature. The respective prevalences are: $Li_3^7 - 92.6\%$; $Be_4^9 - \approx 96\%$; and $B_5^{11} - \approx 81.5\%$.

These isotopes have in fact the extra neutron attached so that the negative end is pointed outwardly, wherefore these elements react so easily with other protons or neutrons, which in turn explains the relative scarcity of these elements in our universe. For the better understanding of the fluid-mechanical structure of the neutron and of the nuclei of named isotopes Li_3^7, Be_4^9, B_5^{11} reference is made to Fig. 3 and Figs. 4a, 4b and 4c.These structures are logical results of fluid mechanical physics considerations. The likelihood of these structures are also indicated by A. G. Gulko in Vortex Theory (1980). A number of analogies also exist in the work of M. Planck; (see: F. Winterberg, 1990 in Z. Naturforsch. 45: Planck Aether Model of a Unified Field Theory and Z. Naturforsch. 46: A Model of the Aether comprised of Dynamic, Toroidal Vortex Rings. There are also numerous publications, which carry elementary physics subject matters, which show some aspects which relate to the theoretical work of this Inventor.

Reference be also made to publications by; T .H. Boyer (1975), M. B. King (1994), B. Haisch (1996) and R. N. Mills (1998) and others.

Inventor has greatly expanded Fluid Mechanical Physics and has been able to determine the dimensions and energies of the rotational, irrotational and helical component flows of the elementary ``vortex toroid''. The latter is the basic ``Closed Vortex Entity''. Composites thereof, which are known as the ``particles'', are built up and constituted by ``vortex toroids''. Also the dimensions, energies and other factors as charge and spin of the muon neutrino, electron, positron, proton, neutron and meson have been determined by Inventor. A listing of the energies, charge and spin characteristics of some of the here named ``particles'' is taken up herein and shown as Fig. 10. Inventor also laid a ``bridge'' to some aspects of the (unnecessary) Quark Theory, which comprises other artificial conceptions.

Referring to Fig. 3: The neutron is a composite particle, consisting of a proton and an electron, which are held together and simultaneously kept apart by an anti-neutrino. More detailed description is in FCU, Part I, Chapter 4.3 and in Part II. Referring to Figs. 4a, 4b and 4c, which show the nuclei of Li_3^7, Be_4^9, B_5^{11}, the reader note the positioning of the extra neutron to the nucleus; how it is attached and how it is pointed outwardly, so that a positively charged entity, as the proton and the positive end of the neutron, can be attracted. Referring to Figs. 5 and 6: these show the double-vortex-ring structures (or vortex pairs) of the proton and the electron. See FCU, Part I, Chapters 3.3 and 3.4.

Existing, accepted physics clearly has problems in certain areas of application of the Bohr Theory and also with the Schrodinger equation. Sub. Bohr: With $\frac{mv^2}{2} = kT$, then at $T = 0K$, the orbital energy would be 0 and the electron would spin into the proton and the charges would be annihilated. This does not happen; wherefore Bohr is certainly wrong in the low temperature range. Also citing a formulation as set up by M.Planck: $U = \frac{h\nu}{e^{\frac{h\nu}{kT}}-1} + \frac{h\nu}{2}$ we see that at $T = 0K$, that there is a remaining energy being equal to $\frac{h\nu}{2}$.This is in full accordance with Inventor's work and this energy equals the total of the rotational, irrotational and helical component flow energies of the electron, which is also its basic constitutional energy, which is $511KeV$. Fig. 7 shows a detail drawing of a proton being in a ``bound'' status to an ``electro-negative end'' of a neutron, while it is being approached by a ``free electron''. Note the ``fluid flows''; in order to overcome the ``binding energy'' with which the considered proton is bound to the ``electro-negative end'' of the extra neutron in Be_4^9; it must come closer to the proton than with the normal bonding in the ``ground-state''. Therefore this electron must ``cross'' or ``fall through'' one or more quantum levels, which causes the creation of ``fractional hydrogen'' and a photon of related energy. Since the ``fractional hydrogen'' atom has a smaller size, it is more difficult to contain; ``Lower fractional states'' can leak through certain energy barriers or ``walls''. It was observed by Inventor in lab runs with the process of this Invention, wherein ``fractional hydrogen'' was being formed, that the pressure inside the totally sealed reactor

lowered somewhat even while the temperature had increased.

The possibility for ``fractional hydrogen'' to react with other elements e.g. O and N is virtually nill. For all practical purposes, the ``fractional states'' of hydrogen are inert. However ``fractional states'' can react with each other, which is reflected in the foregoing, by formula (6). Research and development is being done by Blacklight Power Inc., a New Jersey, US company, with regard to reactions involving ``fractional states'' as well as reactions with ``Bi-electronic hydrogen, the ions of which were named hydrino's by Blacklight Power Inc. An invention, patented under US nr 6,024,935 by R. N. Mills et al. shows that the invention and methods which are mentioned therein are very different and in a different area when compared with this Invention and this application for patent. Blacklight Power Inc.'s technology which is disclosed in US pat. nr. relates primarily to electro-chemistry and in particular to electrolytic processes with potassium complexes.

In lab runs with the process of our Invention it has been shown that ``fractional states'' react with each other, which also results in further production of protons, which in turn minimizes the need for electric power for the purpose of ionization, which is an objective and which makes that process ``over-unity'' is reached rather easily.

In the following there is a comparison of energy yields between the process of this Invention with:

a. Thermo-nuclear Fusion

b. Conventional Combustion of hydrogen with oxygen.

Assume ``fractional hydrogen'' is being formed from the ``ground-state'' to ``state'' $n=\frac{1}{6}$; then photon energy is emitted of about $\frac{1}{2}KeV$ and if the ``state'' of $n=\frac{1}{9}$ were reached then about $1.1KeV$ is emitted. E.g. if an electron were to go from $n=\frac{1}{2}\rightarrow n=\frac{1}{10}$ then roughly $1KeV=1.6\times10^{-16}Joule$ energy becomes available. Considering: Thermo-nuclear Fusion in the sun: (See many publications on this subject matter, e.g. in Scientific American, by John Bahcall of Cal.Tech) reactions which likely take place are:

$$\text{proton+proton}\Rightarrow\text{deuterium+positron+}420KeV\ ,$$

$$\text{proton+electron+proton}\Rightarrow\text{deuterium+}1.44\,MeV\ .$$

This shows that the energy yield of the process of this Invention is in the 1/1000× category compared to the yield of thermo-nuclear fusion in the sun and which after many years of research and billions of dollars of expenses has never been copied on any sustainable basis on earth. Considering: Conventional Combustion of hydrogen with oxygen. The energy produced by molecular hydrogen combustion is 51,600 Btu/Lb, which is 118,700 kJ/kg. One mole of hydrogen contains 6×10^{23} molecules (Avogadro nr.); molecular weight of hydrogen being 2, means that that the energy per hydrogen atom is 118.7 kJ/gr, divided by 6×10^{23}, which is $1.2516eV$ per hydrogen atom. The conclusion is that the process of this Invention is in the category of producing 500 - 1000× more energy per atom of hydrogen than the combustion process can produce, wherefore the technology of this Invention provides for a `quantum leap' in progress for

the production of energy. Recent lab runs show substantial ``overunity''. Outgoing electric power and heat together are substantially ( e.g. > 4 ×) greater than the required ingoing electric power. Two control mechanisms are desirable: a. The intermittent addition of hydrogen be controlled by the pressure and possibly also by removal of ``fractional and bi-electronic hydrogen'' for temporary storage for later use purposes. b. The voltage differential between cathode and anode be controlled majorly by temperature and minorly by the pressure. In a newer further improved process version, no addition of hydrogen during operations is needed, because of a secondary and simultaneously running nuclear transmutational process which produces protons. Also protons are produced if some ``fractional states'' convert into ``lower fractional states'' according to formula (6), although this last named process would not produce enough protons to keep the process continually going, wherefore the need for the nuclear transmutational process.

In the event that ``fractional and bi-electronic hydrogen'' are removed during process operations, then a secondary evacuating pump and storage are needed. Such a sub-system is shown in Fig. 9. ``Fractional hydrogen can react again with ``ground-state'' in a reactor with cathode and anode and having a voltage differential between those and produce radiative energy. Bi-electronic hydrogen can (upon ionization to negatively charged hydrogen ions) form new molecules/materials hitherto unknown.

One can logically assume that process conditions vary widely as to which ``nucleonic catalyst'' is being used. Furthermore many dimensional parameters and alloy composition parameters greatly influence the energy production.

Energy is being produced in two locations:

a. In the cathode area 40 - 80% of the total energy. Radiation is Soft X-ray, extreme UV and some violet to blue. This radiation can be directly converted into electrical power by using the photo-electric effect, wherefore there are a photo-cathode and a photo-anode around the cathode. The wavelengths of this radiation is such that the ``surface-exit-energy'' (is the ``workfunction'') of the electrons in certain metals, e.g. Cs, Rb, Na, K, Ba, Sr has been surpassed. The first and second ``fractional series'' radiation can also free electrons out e.g. Cu and Zn.

b. In the ionization area 20 - 60% of the total energy. Radiation is from the blues to pink. This radiation is best used as heat, either directly or for powering a thermo-dynamic cycle, including a Stirling cycle.

With reference to a., two modes of construction have proven to be possible. One is featuring a chamber around the cathode area from which it is separated by a radiation transmitting material, e.g. quartz. Inside the chamber are the photo-cathode as a shield against the outer wall of this chamber and the photo-anode, which can be either against the sides of said chamber or be a screen diametrically inside of the photo-cathode. The photo-anode be made of an electro-conductor. If the photo-cathode is covered with an element with a relatively low energy ``workfunction'', e.g. Cs, Rb, Na, K, Ba, Sr, then this chamber must be void of oxygen, wherefore it must be first evacuated and then filled with an inert gas, e.g. Ar. The second mode of construction, which was discovered in the

fall of 2000 is by bringing the photo-cathode and photo-anode inside the reactor, but being electro-magnetically isolated from the electro-static and electro-magnetic fields which exist between the cathode and anode in the reactor. This isolation is established by constructing a so called ``Cage of Faraday'' around the cathode assembly, which allows sufficient space for the electro-static and electro-magnetic fields, so that protons can approach the cathode unhindered at all locations. The openings in the ``Cage of Faraday'' as well as the openings in the photo-anode are sufficiently large and best also aligned with each other, so as to allow that radiation from the cathode can easily reach the photo-cathode. In operation small voltage differentials are in effect between the photo-cathode and photo-anode, respectively ``Cage of Faraday''. Substantial electric currents then result if sufficient radiation of short enough wavelengths is available. This electric power is electronically converted to a DC status at a voltage level, so that it can be directly used for powering the primary electrical circuit (of which the cathode and anode are part) and/or be stored into the intermediate electric power storage (small battery). If the electric power production is greater than the electric power use (``overunity''), then the excess power is available for whatever use. Also electric power can be substantially produced from that part of the radiation in the ionization area, which is in the 400nm - 900nm range , by using *GaAs/Ge* photo-voltaic cells. The electrical output efficiency runs up to 20% of all radiation in the ionization area which is in the 400nm - 900nm range. The remaining 80% becomes available as heat.

Some heat is produced in the cathode area although most radiation in this location is of sufficiently short wave-lengths that direct photo-electric conversion can take place; the majority of the heat (80% plus) is produced in the ionization and anode areas. This heat can be used either directly or for powering a cycle system (e.g. a Stirling system). Fig. 8 shows a reactor system with an annular space surrounding its cathode area, from which photo-electricity is being produced and a jacket around the ionization area for the collection of the convective heat, which is produced by this area. Fig. 9 shows a reactor system, which has a diametrically enlarged cathode area in which the ``Cage of Faraday'' and photo-cathode and photo-anode are located and from which the photo-electricity is being produced as well as a jacket around the ionization area for the collection of the convective heat, which is produced by this area. Fig. 8 and Fig. 9 have corresponding legends, which are indicated as Fig. 8a and Fig. 9a.

PROCESS DESCRIPTION

Referring to the laboratory layout as shown in Fig. 8:
By means of variac (variable tranformer) (1), transformer (2), bridge rectifier or `half' rectifier (diodes) (3) and `filter' (4), a wide range of more or less pulsed DC is available between cathode and anode (5). The ionization area (6) is shown with a Tungsten coil and high frequency power source (7). The latter feature is optional. (if the ends of the Tungsten coil are placed close to anode and cathode, then electric induction takes place, which has proven to be sufficient for the further promotion of the ionization of hydrogen.

Cathode (8) is surrounded by reactor tube section (9), which is preferably made of quartz, which allows high transmissivity for UV. The annular space around (9) is indicated by (10); inside it has at its outer perimeter the photo-cathode (11), which may be made of Cu or Cu/Zn. These materials allow the `photo-electric' effect to occur from the first ``fractional series'' of hydrogen on down. For better utilization of some longer wave-lengths in the UV an inner surface layer (11) made up of suitable element(s) e.g. Ba,K,Rb,Cs is applied. The photo-anode(s) (12) are shown imbedded in the sides of the annular space, but (12) can be placed as a concentric screen (inwardly from the photo-cathode) as well. Because of the low values for the ``ionization constant'' of the elements e.g. Ba,K,Rb,Cs the annular space is filled with an inert gas e.g. Ar, after first having been evacuated. Both the reactor system (00) and annular space (10) are hooked up to vacuum-pump system (13). The mV gauge (14); the mAmp gauge (15) and Watt-integrator (16) are part of the photo-electric circuit; the voltage for this circuit is being supplied by potentiometer (17); this voltage needs to be regular fairly constant DC, wherefore a `filter' might be taken up in this circuit. Volt-meter (18), Watt-meter (19), recorder (19a) and mAmp.-meter (20) are part of the primary electrical circuit of reactor system (00). The pressure sensor-gauge and motorized valve (21) can cause hydrogen to be supplied to the reactor system at a controlled pressure level. This hydrogen can be supplied by either an electrolysis unit (22) or by a bottle (23). Thermocouples (24) give read-outs at (25), which is also connected to voltage control (25a). A jacket type heat-

exchanger is positioned around reactor system (00) and is indicated by (26). This jacket can be extended to include the anode area as well, so as to utilize most of the produced heat.

OPERATION

(The operation described below refers to the laboratory set-up as is shown in Fig. 8 and with the use of Be_4^9 as nucleonic catalyst). (The data given herewith differ from data given in an prior patent application with regard to a largely similar patent application in the USA, which involves the same Invention. Reason for the different data is, that with the high tempo research program, which is connected to the patent application of this Invention, several process parameters were already altered, particularly with regard to cathode and anode compositions, which makes for different and more up-to-date process data).

After evacuation of the reactor system (00) and the multiple purgings with hydrogen, hydrogen is let into the reactor system at the `early' operating pressure of 1500 mT. Also the annular space is evacuated and then filled with Ar.

After applying a DC voltage differential of 500 - 550 Volts and a simultaneous super-positioned AC voltage of specific character of about 900 Volts, plasma is formed and shows in all sections of the reactor system. After a few minutes the Voltage can be regulated back by 50-100 Volts DC. After this, the pressure is allowed to

-increase to 2500-3000mT. A current establishes itself in the range of 2-5 mAmps. This means a power consumption of the reactor system of 1 - 3 Watts. In the ionization area the plasma colors from deep pink, to light pink, light blue into violet. In the cathode area there is blue (and violet if the element *Ti* is part of the composition of the cathode), furthermore in the (invisible for the eye) extreme left UV and soft X-ray there are the first and second ``fractional series'' ($n=\frac{1}{2}$ resp. $n=\frac{1}{3}$ in the Rydberg formula).

With output voltages of 2 - 4 Volt between photo-cathode and photo-anode and about 1.5 Volt between photo-cathode and ``Cage of Faraday'' and mAmps ranging from 3 - 20 mAmps, in total about 20 - 120 mW photo-electricity was produced in the test with ATS in Marietta, Ga. These results have been improved on in April 2001 by a factor 100% plus. (These results were obtained with a photo-cathode existing of *Cu* only). With using elements on the photo-cathode surface, which have a much lower ``ionization constant'', the photo-electricity can greatly increase, e.g. a factor of 10×. Heat production in the ionization and anode areas has been far ``over-unity''; for a section of the ionization area alone, a value from the test referred to, shows a 2.19 ``over-unity'' versus the power input as a whole. In a test in April, 2001, about 5/1 heat ``over-unity'' was measured. Total heat and electric ``over-unity'' with a newer test unit, which has several parameters substantially improved, should exceed 7/1. Referring to the laboratory lay-out as is shown in Fig. 9: Better results were obtained

with it. For the identification of the components of the layout of Fig. 9, consult the legend: Fig. 9a.. Less power input is required with closer proximity of anode and cathode and with proper electric induction in the Tungsten coil for the production of the same power output. It was recently established that after extending runs into many hours, the overall production of heat as well as of electricity increased substantially. The reason for this is that gradually more ``fractional hydrogen'' of the first ``fractional series'' reacts with ``ground-state'' hydrogen according to formula (6) and forms ``fractional hydrogen'' of the second and third ``fractional series''. In these conversions there is much more photon energy becoming available: respectively 108.8 and 204.0 eV per atom of hydrogen. For the further utilization of heat produced in the ionization area, particularly if the temperature difference over the reactor wall exceeds 20^0C a special Stirling system can be employed (Rentz system), which is relatively quite effective if only low temperature differentials are available. This Stirling system then in turn provides for shaft power. Inventor however has opted for the utilization of $GaAs/Ge$ instead, whereby a photo-electric conversion efficiency of 20% or better can be guaranteed. The Boeing, Spectrolab Division has already reached a maximum conversion efficiency level of 33.2%. Fig. 9 also shows a secondary vacuum pump system (12), which is there for the purpose of collecting samples of ``fractional hydrogen'' and or of bi-electronic hydrogen'' into storage tank (13), for the purpose of further testing, either for energy generation or for new materials research and development.

Clearification on the subject ``Electro-negativity''

``Electro-negativity'' is that characteristic of a nucleus of an atom, which expresses itself as a location at or in the nucleus where there is a need for fluid energy inflow.

According to Fluid-Mechanical Physics, the Introduction to which is described in Fluidum Continuum Universalis, Part I, which is a book written by Inventor (this book is available at www.greatunpublished.com # 270), electrons have a strong need for axial/polar fluid inflow. The electron is also part of the neutron, in that a neutron is composite entity which consists of a proton at one end and an electron at the other end, both of which are being kept apart as well as together by an anti-neutrino. Neutrons are quite unstable when on their own (11 minutes half-life), but when bound in nuclei, which is via their negative end, which can attract one or two protons simultaneously, neutrons are stable. All areas at or in nuclei which have an electronic end exposed, which is not supplied with fluid energy by a closely located proton are ``electro-negative'' areas. If these areas are accessible by protons then bonding with protons will occur. This process is one of the two which are active and responsible for nucleo-synthesis. Particularly the isotopes $Li_3^7, Be_4^9 B_5^{11}$ have extra neutrons to their nuclei, which provide for a greatly exposed negative end; these nuclei have few electrons attached and can easily be approached by protons. The elements: Cd, In, As, Sb have prevailing isotopes, which also have electronegative areas, however they are less exposed when compared with Li, Be, B; such is the case with the elements Pd, Pt, they have even more than one electro-negative area in their nuclei, but they are not exposed.

Claims

1. Method of generating energy comprising the steps of:

   a. introducing hydrogen into a reactor vessel, the vessel comprising a cathode, an anode and an ionization element, wherein the cathode comprises a catalyst element having in its nucleus a number of neutrons which is larger than the number of protons and wherein at least one neutron has a preferred orientation,
   b. ionizing at least a part of the hydrogen with the ionization element to form a plasma,
   c. applying a voltage differential across the cathode and anode, causing protons to travel to the cathode, bind to the catalyst element's nucleus at instants of low or zero voltage differential, after which being released by attraction from "free" electrons, thus forming "fractional" hydrogen and photons, and
   d. collecting heat and other photon energy generated in step c. and possibly collecting and storing at least a part of the formed "fractional" hydrogen and/or "bi-electronic" hydrogen.

2. Method according to claim 1, wherein the catalyst element comprises an element of the group consisting of Li_3^7, Be_4^9 and B_5^{11} and/or any combination thereof as an alloyed element.

3. Method according to claim 1 or 2, wherein the cathode comprises an element from the Platinum group (Group VIII), Al, Mg, Ti, or any combination thereof, together with the alloyed element under claim 2.

4. Method according to any of the preceding claims, wherein the pressure in the reactor vessel is reduced and maintained within certain limits.

5. Method according to any of the preceding claims, in which the ionization means comprises a metal element.

6. Method according to claim 5, a high frequency voltage being applied across the metal element.

7. Method according to claim 5, the positioning of the metal element being close to either anode or cathode, causing self-induction.

8. Method according to any of the preceding claims, a time-varying voltage being applied between anode and cathode.

9. Method according to any of the preceding claims, a convertor being provided near the cathode for collecting radiation produced at or near the cathode and for converting the collected radiation into electricity.

10. Method according to any of the preceding claims, wherein a heat exchanger is provided and heat is extracted from the reactor vessel.

11. Method according to any of the preceding claims, wherein the temperature in the reactor vessel is being monitored and this temperature being one of the controlling factors of the voltage differential between anode and cathode.

12. Method according to any of the preceding claims, wherein the pressure in the reactor vessel is being measured, and the amount of hydrogen that is

introduced into the reactor vessel being controlled by the pressure.

13. Method according to any of the preceding claims, wherein the measured pressure also is a controlling factor together with the measured temperature of the voltage differential between anode and cathode.

14. Apparatus for generating energy comprising:

- a reactor vessel having a cathode, an anode spaced at a distance from the cathode and an ionization element between the cathode and the anode, wherein the cathode comprises a catalyst element having in its nucleus a number of neutrons which is greater than the number of protons and wherein at least one neutron has a preferred orientation,
- a power source connected to the cathode and anode for providing a specific time dependent voltage between cathode and anode,
- pressure reducing means for lowering the pressure in the reactor vessel, which afterwards is maintained as result of the smaller "fractional" hydrogen atoms which are being formed,
- a hydrogen supply connected to the reactor vessel,
- radiation collector means being located around the cathode, either in or outside the reactor vessel,
- heat collector means being applied, either in- or outside the reactor vessel, and
- an outlet provided to the reactor for possible removal of "fractional" hydrogen and/or "bi-electronic" hydrogen.

15. Apparatus according to claim 14, the cathode having an alloyed element of the group consisting of Li_3^7, Be_4^9 and B_5^{11} or any combination thereof.

16. Apparatus according to claim 14 or 15, wherein the cathode comprises of an element of the Platinum group (Group VIII), Al, Mg, Ti or any combination thereof, together with the alloyed element of claim 15.

17. Apparatus according to any of claims 14 to 16, wherein the ionization element comprises a metal coil.

18. Apparatus according to claim 17, the coil comprising W.

19. Apparatus according to any of the claims 17 or 18, a high frequency voltage being applied to the coil.

20. Apparatus according to any of the claims 17 or 18, the positioning of the coil, either as to anode or cathode being such that self-induction can occur.

21. Apparatus according to claim 14 or 15 or 16, a specific time dependent voltage being applied between anode and cathode.

22. Apparatus according to claims 14 to 20, the reactor vessel comprising in the area of the cathode a window of radiation transmissive material, an annular chamber surrounding the reactor vessel in the cathode area, a radiation absorbing material being located within the annular chamber which functions as photo-cathode and a photo-anode being located within this chamber.

23. Apparatus according to claim 22, the radiation transmissive material being quartz.

24. Apparatus according to claim 22, the photo-cathode comprising of Cu or Zn or elements with a low ionization constant, e.g. Ba, Sr, K, Ru or any combination thereof.

25. Apparatus according to claim 24, whereby an element with a low ionization constant, e.g. Ba, Sr, K, Ru be applied in the form of strips against a background surface of either Cu or Zn.

26. Apparatus according to claims 22 to 25, the annular chamber being filled with a noble gas.

27. Apparatus according to any of the claims 14-26, the photo-cathode and photo-anode being located within the reactor vessel and around the cathode, being spatially positioned away from the cathode at the outside of a "cage of Faraday", which is positioned around the cathode.

28. Apparatus according to claim 27, the photo-anode being positioned between the "cage of Faraday" and the photo-cathode.

29. Apparatus according to claim 28, the photo-anode being a metallic screen.

30. Apparatus according to any of the claims 27 to 29, whereby the photo-cathode comprises of Cu or Zn or an element with low ionization constant, e.g. Ba, Sr, K, Ru or any combination thereof.

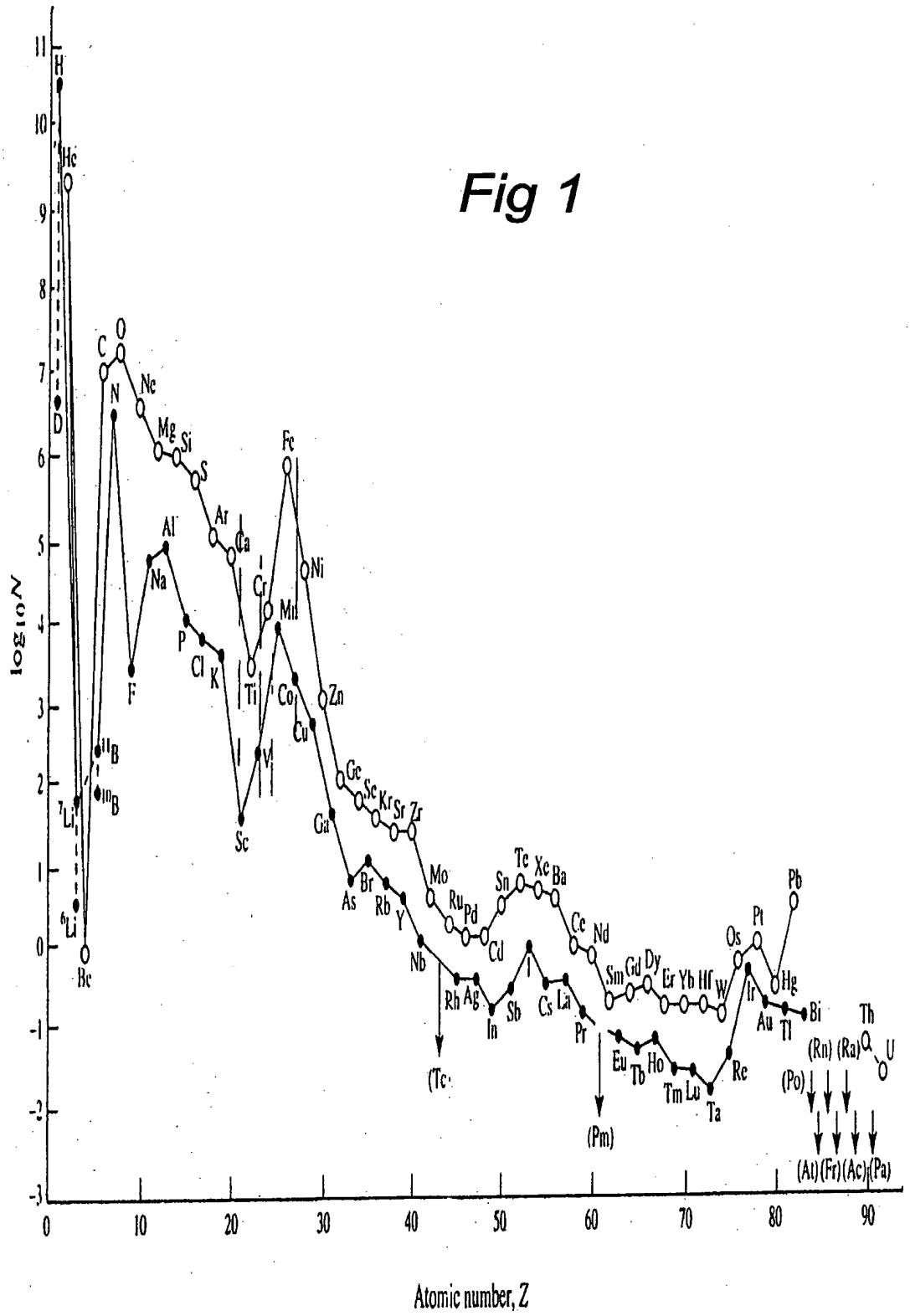
30. Apparatus according to claim 30, whereby an element with low ionization constant,
e.g. Ba, Sr, K, Ru is being applied against the background surface of Cu or Zn, which may be
in the form of strips

31. Apparatus according to claims 14 to 30, the reactor vessel comprising an outlet for the possible removal of "fractional" hydrogen and or "bi-electronic" hydrogen.

32. Apparatus according to claims 14 to 30, the reactor vessel comprising concentric therewith a heat exchanger.

33. Apparatus according to claims 14 to 30, the cathode and anode having internal cooling means, e.g. heat-pipe or liquid cooling.

Fig 1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He
D
C
O
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Ne
Mg
Si
S
Ar
Ca
Fe
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Cr
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P
Cl
K
Ti
Co
Cu
Zn
Ga
Ge
Sc
Kr
Sr
Zr
Mo
Ru
Pd
Sn
Te
Xe
Ba
Ce
Nd
Sm
Gd
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(Po)
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(Fr)
(Ac)
(Pa)
(Tc)
(Pm)
F
Li
Be
B
As
Br
Rb
Y
Nb
Rh
Ag
In
Sb
Cs
La
Pr
Eu
Tb
Ho
Tm
Lu
Ta
Re
Ir

Fig 2

$n_{Rydberg}$	$E \rightarrow Gr.St.$ (eV)	$E \rightarrow \infty$ (eV)	ΔE (eV)	λ (A)
1 "Ground State"	0	-13.6	$n_i \rightarrow n_f$	912.0
$\frac{1}{2}$	-40.8	-54.4	$1 \rightarrow \frac{1}{2}$ 40.8	303.9
$\frac{1}{3}$	-108.8	-122.4	$\frac{1}{2} \rightarrow \frac{1}{3}$ 68.0	182.4
$\frac{1}{4}$	-204.0	-217.6	$\frac{1}{3} \rightarrow \frac{1}{4}$ 95.2	130.2
$\frac{1}{5}$	-326.4	-340.0	$\frac{1}{4} \rightarrow \frac{1}{5}$ 122.4	101.3
$\frac{1}{6}$	-476.0	-489.6	$\frac{1}{5} \rightarrow \frac{1}{6}$ 149.6	82.9
$\frac{1}{7}$	-652.8	-666.4	$\frac{1}{6} \rightarrow \frac{1}{7}$ 176.8	70.1

Fig 3

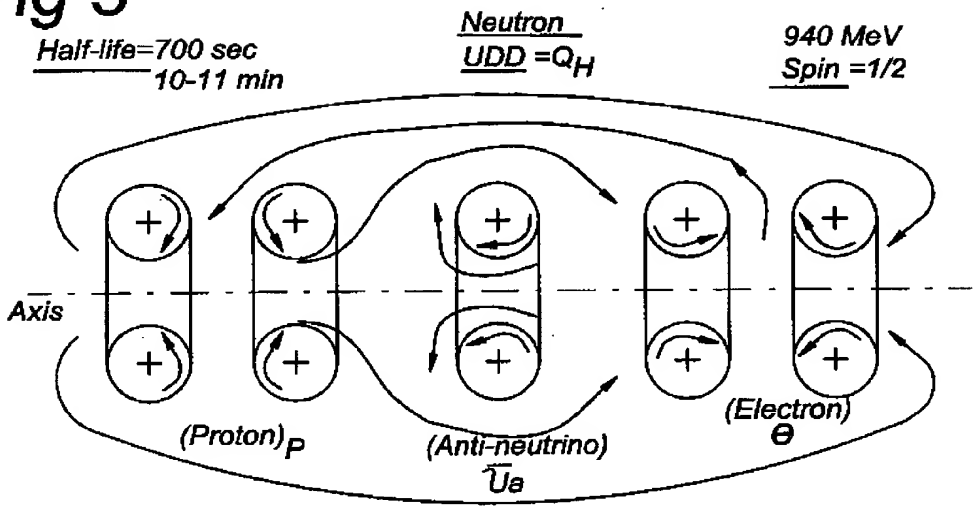

Fig 4a

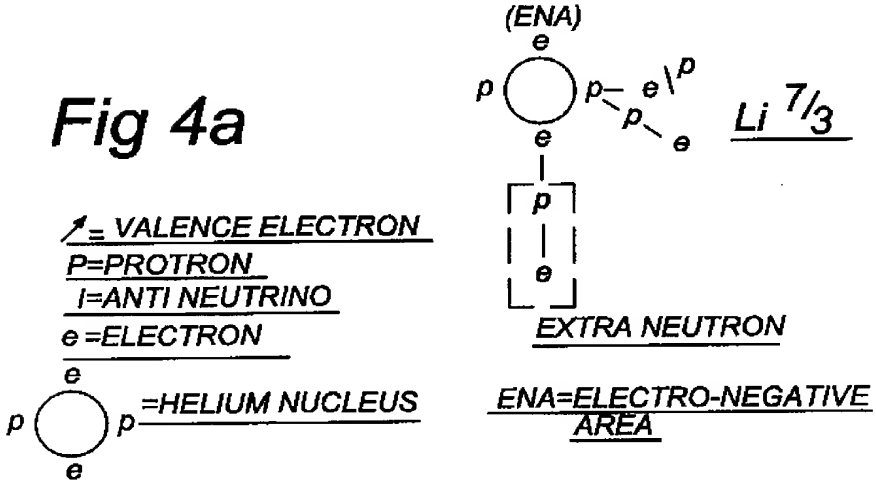

Fig 4b

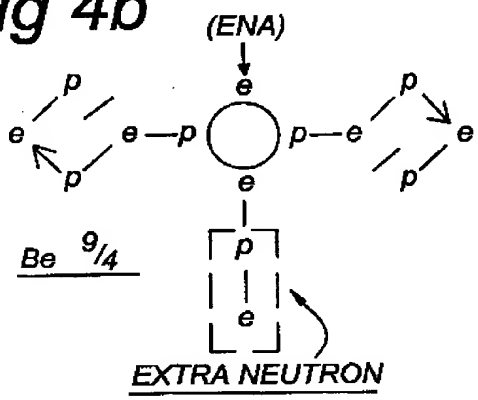

Fig 4c

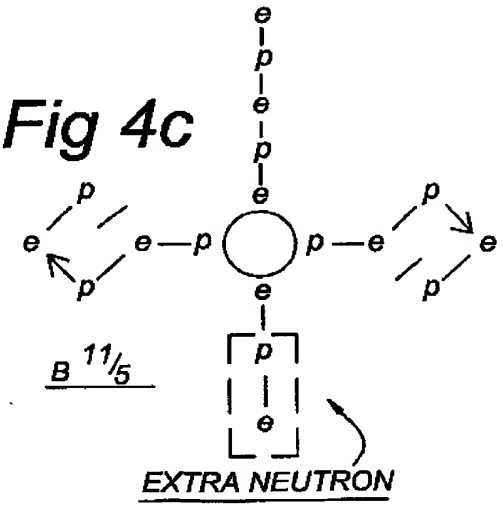

Fig 5

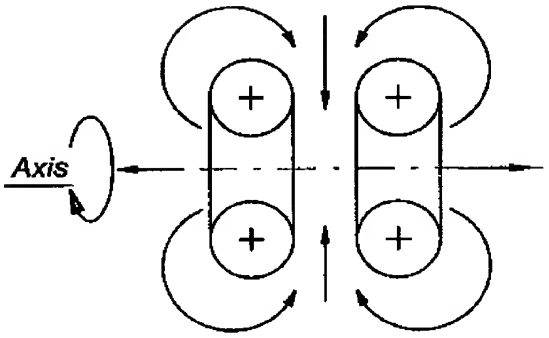
Axis
PROTON
Q_H : UUD
938 MeV,SPIN 1/2

Fig 6

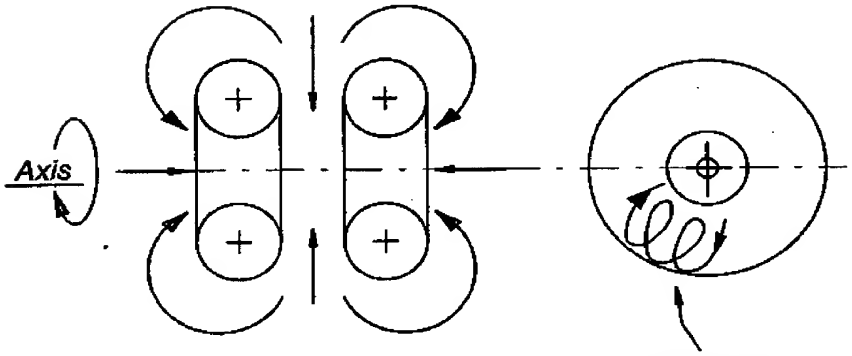
Axis
ELECTRON
QI :UDD
511 KeV,SPIN 1/2
"GR.STATE"
TOROIDAL
SPIRALING
SIDE VIEW

Fig 7

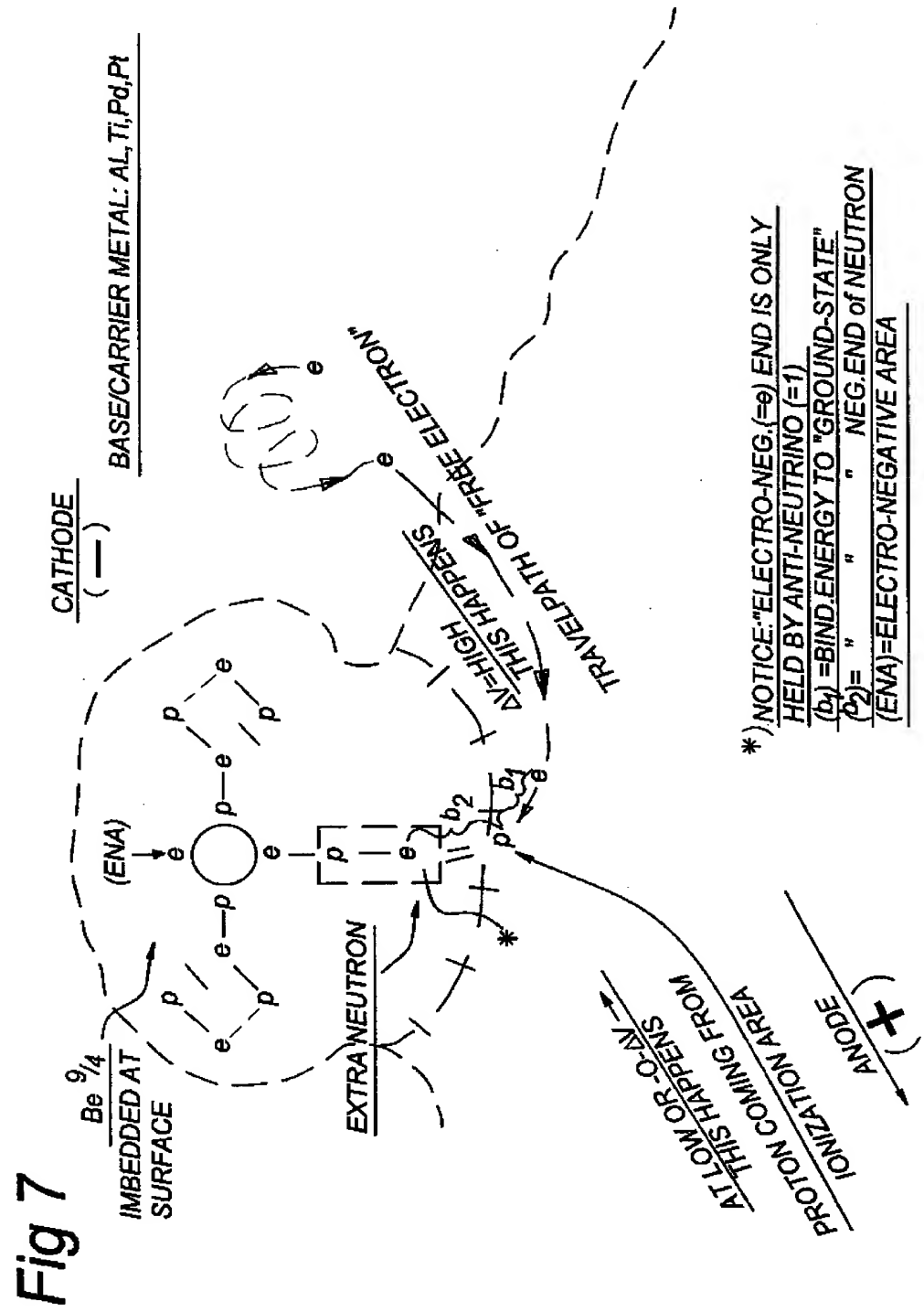
Be 9/4
IMBEDDED AT SURFACE
(ENA)
EXTRA NEUTRON
CATHODE
(—)
BASE/CARRIER METAL: AL, Ti, Pd, Pt
AV=HIGH HAPPENS
THIS HAPPENS
TRAVEL PATH OF "FREE ELECTRON"
*) NOTICE: "ELECTRO-NEG.(=e) END IS ONLY HELD BY ANTI-NEUTRINO (=1)
(b_1) =BIND.ENERGY TO "GROUND-STATE"
(b_2)= " " NEG.END of NEUTRON
(ENA)=ELECTRO-NEGATIVE AREA
AT LOW OR-O-AV
AT THIS HAPPENS
PROTON COMING FROM
IONIZATION AREA
ANODE
(+)

Fig 8

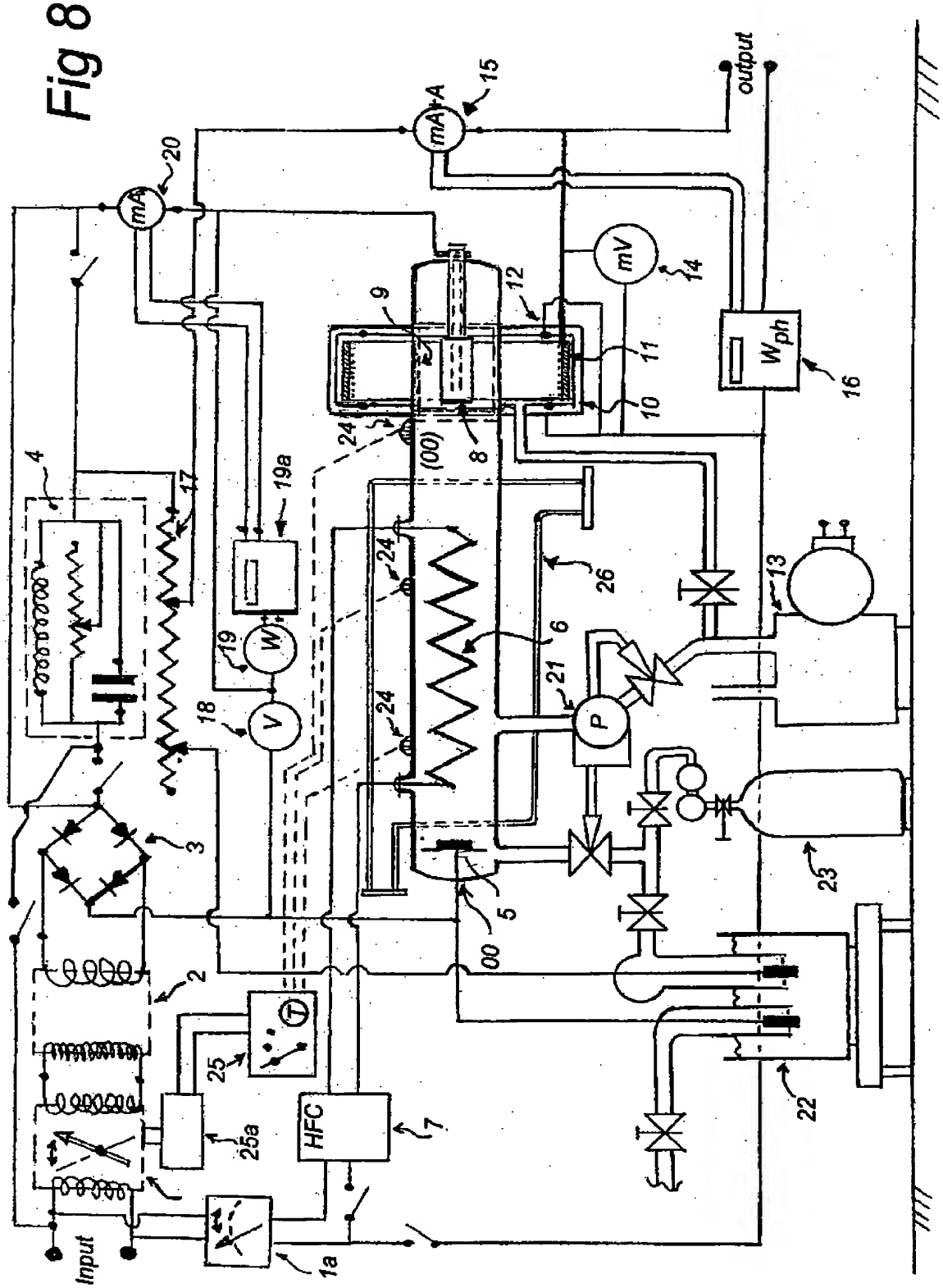
output
mA
15
20
mV
14
12
9
11
10
W_{ph}
16
24
(00)
8
4
17
19a
19
W
18
V
26
13
6
21
P
3
2
25
T
25a
HFC
7
5
00
23
22
Input
1a

Fig 8a

(00) = Reactor-tube			
1	Variac , 1a small variac	14	m-Volt Gauge (photo-circuit)
2	Transformer (up)	15	m-Amp-A Gauge (ph-circuit)
3	RECTIFIER-bridge	16	Wattage Integrator
4.	"Voltage-flattener" (LCR)	17	Potentiometer
5	Anode (prim.circuit)	18	Volt-meter (0 – 1000 V)
6	Tungsten Coil	19	Watt-meter , 19a Integrator
7	High Frequency Control	20	m-Amp meter (0 – 10 mA)
8	Cathode + Nucleonic Cat.	21	Pressure Sensor/Actuator
9	Quartz "window" section	22	Electrolysis Unit
10	Housing of annular space	23	Bottle of hydrogen
11	Radiation Absorber + K (= photo-cathode)	24	Thermo-couples
		25	Temp. Read-Out
12	Photo-Anode(s)	25a	Voltage Control
13	Vacuum-pump system	26	Heat Exchanger envelope

Fig 9

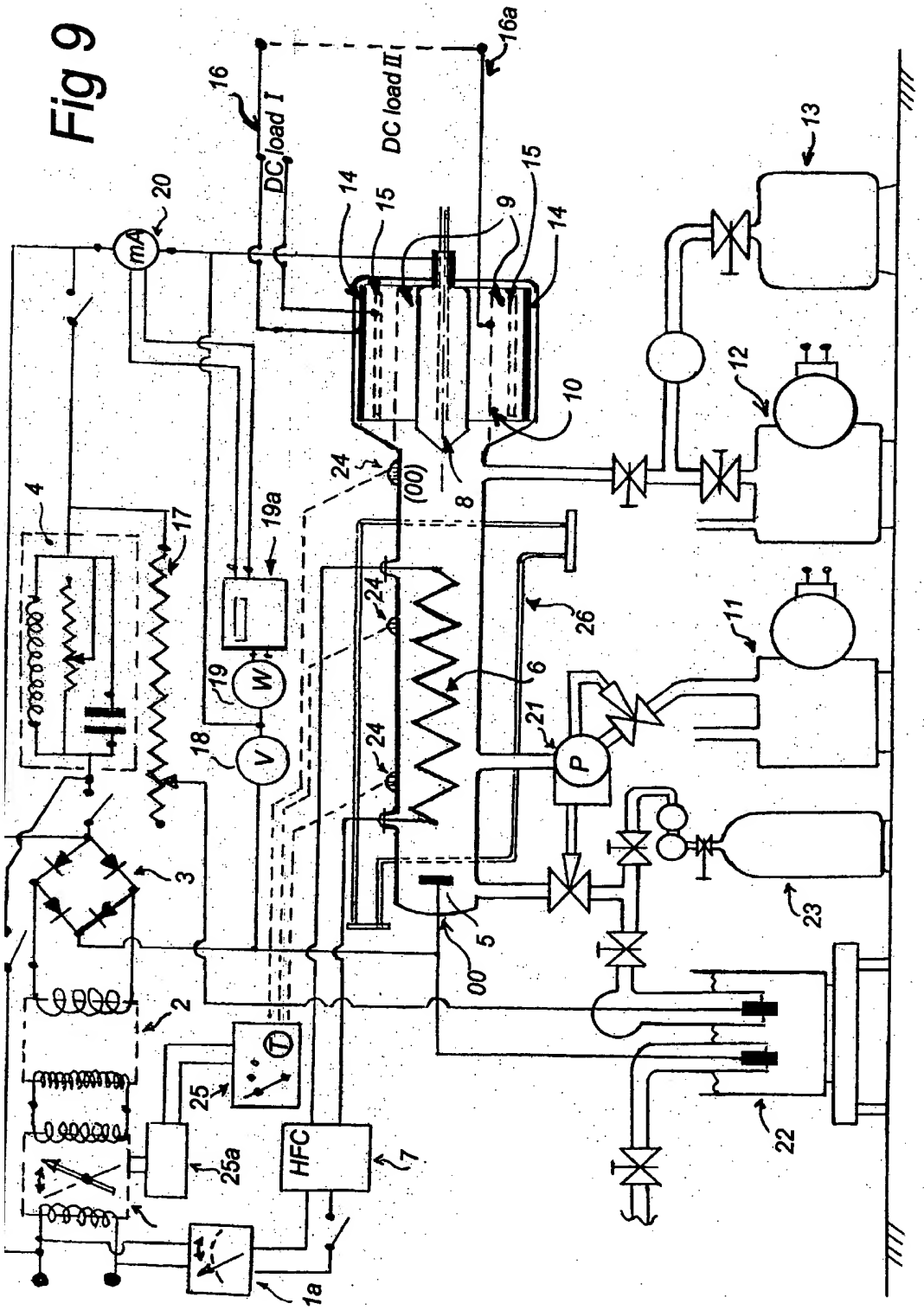
DC load I
DC load II
16
16a
20
mA
14
15
9
10
8
24
(00)
4
17
19a
19
W
18
V
6
26
11
21
P
12
13
3
2
25
T
25a
HFC
7
1a
5
00
23
22

Fig 9a

(00) = Reactor-tube			
1	Variac , 1a small variac	14	Photo-cathode
2	Transformer (up)	15	Photo-Anode
3	RECTIF. –bridge	16 16a	ELECTRIC TERMINALS I ELECTRIC TERMINALS II
4.	"Voltage-flattener" (LCR)	17	Potentiometer
5	Anode (prim.circuit)	18	Volt-meter (0 – 1000 V)
6	Tungsten Coil	19	Watt-meter , 19a Integrator
7	High Frequency Control	20	m-Amp meter (0 – 10 mA)
8	Cathode + Nucleonic Cat.	21	Pressure Sensor/Actuator
9	"PHOTO-CONVERT.U section	22	Electrolysis Unit
10	"CAGE OF FARADAY"	23	Bottle of hydrogen
11	Vacuum-pump system	24	Thermo-couples
* 12	Secondary Vacuum pump	25 25a	Temp. Read- Out Voltage Control
* 13	"Fract"-hydrogen storage	26	Heat Exchanger envelope

* RELATES TO OPTIONAL FRACTIONAL & BI-ELECTRONIC HYDROGEN REMOVAL

Fig 10

	Fluid Dynamic "Mass"	Classical Physics Mass	Fluid Dynamic Energy Rate	Classical Physics Energy	Fluid Dynamic Charge Force	Fluid Dynamic Spin Energy Rate
			Potential Energy			Spin Velocity
Unit Expression	$\rho_o d^3$	kg	$\frac{\pi}{4}\rho_o d^2 c^{*3}$	Joule	$\rho_o d^2 c^{*2}$	$\rho_o d^2 c^{*3}$
			$\rho_o c^{*2}$	eV		c^*
Dimen-sionality	$N_{el.u.}$	kg	$N_{el.u.}L^2T^{-3}$	ML^2T^{-2}	$N_{el.u.}LT^{-2}$	$N_{el.u.}L^2T^{-3}$
			$N_{el.u.}L^{-1}T^{-2}$			LT^{-1}
Electron-Neutrino/-Anti-Neutrino	$\approx 6\times10^{-3}$	$\approx 5\times10^{-36}$	≈ 1.1	<5eV	N.A.	$\approx .1$
Muon-Neutrino	≈ 7.5	3.7×10^{-34}	≈ 2.0	207eV	N.A.	$\approx .18$ .064
Proton/Anti-proton	≈ 60	1.67×10^{-27}	6.00 .40	938MeV	≈ 3.0	$\approx .3$ .064
Electron Positron "at rest"	Pos. 2.73 Neg. 2.70 Net .327	9.1×10^{-31}	≈ 2.2	511KeV	.00128	$\approx .06$ .064
Electron "in motion" $v=.99c^*$	≈ 59	$\approx 1.65\times10^{-27}$	≈ 5.9	≈ 900MeV	≈ 2.9	$\approx .29$ .064
Hydrogen Atom	≈ 60.03	$\approx 1.67\times10^{-27}$	≈ 8.2	≈ 938.5MeV	N.A.	4.4×10^{-18}J 2.2×10^{6} m.sec^{-1}

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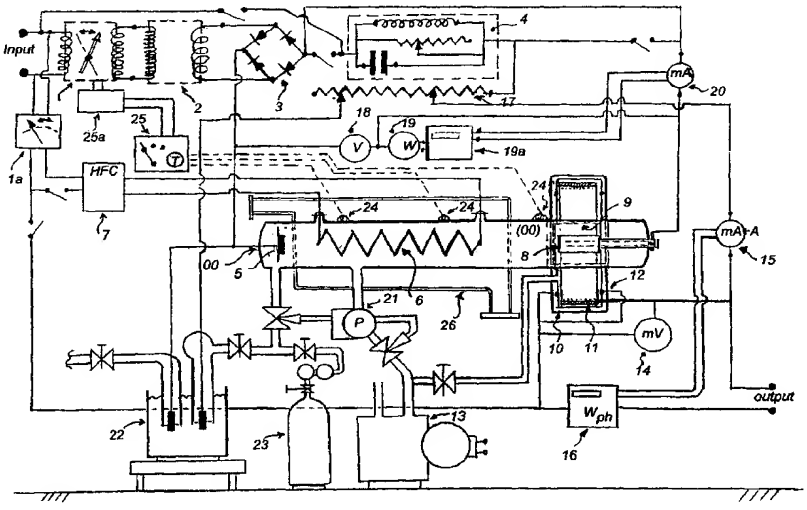
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR THE PRODUCTION OF SO CALLED "FRACTIONAL HYDROGEN" AND ASSOCIATED PRODUCTION OF PHOTON ENERGY



(57) Abstract: An enclosed system, which may be of tubular shape, in which plasma of hydrogen is induced, or is being created and in which this plasma is being maintained. Said system comprising of an anode (5) at one end of the enclosed system and a cathode (8) at the other end; optionally, means for electromagnetic focusing surrounding said enclosed system; coiling, screens or strips, which may have a variety of shapes, positioned within said enclosed system and being located between said anode and said cathode, but not being connected to either and which may consist of a material, which promotes the conversion of molecular hydrogen into atomic hydrogen and which further facilitates the ionization of hydrogen; said coiling, screens or strips, which may have a variety of shapes, optionally being hooked up to a minute electric power source (7).

WO 02/08787 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/21273

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :C01B 3/02
US CL :423/648.1; 422/129
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 423/648.1; 422/129

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,024,935 A (MILLS et al) 15 February 2000, (15.02.2000), entire document.	1-33

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 26 FEBRUARY 2002	Date of mailing of the international search report 15 MAR 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JOSEPH WILLIAMS Telephone No. (703) 305-4794

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/21273

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 3-13, 17-26, 30-33
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.